EFFECT OF FEEDING *MORINGA OLIEFERA* STEMS ON PRODUCTIVE PERFORMANCE OF LACTATING FRIESIAN COWS

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(Received 17/9/2018, accepted 6/11/2018)

SUMMARY

This study was carried out to investigate the effect of partial or all replacement of berseem hay by *Moringa oliefera* stems. Fifteen of lactating Friesian cows with average live body weight of 500 kg (2-4 seasons of lactation after the peak milk yield) were fed covering their requirements recommended feeding allowances for dairy cows. Animals were divided into three groups (5 each) assigned randomly to three experimental rations. Control ration (R1) consisted of 40% concentrate feed mixture (CFM) + 20% corn silage (CS) + 20% rice straw (RS) + 20% barseem hay (BH), While the other rations contained 10 and 20% *Moringa oliefera* stems (MS) instead of 50 and 100% of BH in R2 and R3, respectively. Results revealed that the contents of CP, CF and ash tended to increase, however the contents of OM, EE and NFE tended to decrease with increasing the level of *Moringa oliefera* stems in the rations. Digestibility of DM, OM and CP of 10% MS-ration (R2) were significantly higher than those of control ration (R1) and insignificant higher than those of 20% MS-ration (R3). Otherwise, digestibility of CF and NFE as well as TDN value did not affected significantly by treatments. The value of DCP was significant higher with both tested rations than that of control. Totally, digestibility of most nutrients and feeding values were the highest with R2 and the lowest with control (R1). Daily feed intake and rumen fermentation activities were nearly similar trend among the different groups. Total protein, albumin and globulin concentrations increased significantly ($P<0.05$), but urea-N and creatinine concentrations in plasma decreased significantly ($P<0.05$) with increasing the level of Moringa stems in the rations. Daily yield of actual milk and 4% FCM as well as the percentages of fat, protein, total solids and solids not fat in milk increased insignificantly ($P>0.05$) with 10% MS-ration (R2) and significant increased ($P<0.05$) with 20% MS-ration (R3) compared with control ration (R1). Feed conversion was insignificant improved by the ration included the low level of MS (R2), but the improvement was significant with the ration having the high level of MS (R3) than that of control one (R1). Also, Moringa stems reduced the average daily feed cost and feed cost per one kg 4% FCM, but increased the price of 4% FCM yield and subsequently economic efficiency.

Keywords*: Moringa oliefera stems, cows, digestibility, milk yield and composition, feed and economic efficiency.*

INTRODUCTION

In Egypt, there is an accelerated increasing the gap between the availability degree of feed resources and the demand that covering the nutritional requirements of the existing animals population according to their genetic potentiality. Currently, great attention has been given to Moringa forage by many Egyptian animal nutritionists to overcome the green fodder shortage particularly during summer season. *Moringa* leaves had good quality protein rich in essential amino acids which can enhance dietary N utilization and improve animal productivity as well as *Moringa* forage is rich in most nutrients (Mendieta-Araica *el al*., 2013 and Nouman *et al*., 2013). *Moringa l*eaves have been reported to be a valuable source of both macro and micro nutrients, being a significant source of beta-carotene, vitamin C, protein, calcium, iron, and potassium (Anwar *et al*., 2007; Pullakhandam and Failla, 2007; Siddhuraju and Becker, 2003 and Thurber and Fahey, 2009).

Moringa oleifera can grow in all types of soils and can tolerate dry seasons and lasting up 6 months (Mendieta-Araica *et al*., 2013). Intensive production of Moringa as green fodder can harvested 8 times a year and gave about 300 tons per acre when harvested every 40 days at 50-60 cm high. Moringa plant contains significant amounts of vitamins A, B and C in the foliage with good profile of amino acids (Ferreira *et al*., 2008). It can also be used as a protein meal in livestock diet. Leaves are free from anti-nutritional factors (e.g. phenols, tannins, saponins, etc.) and high in iron (up to 582 mg/kg DM), in beta-carotene (up to 400 mg/kg DM) and in vitamin C (up to 9.2 g/kg DM). Recently, Khayyal *et al*. (2015) concluded that *Moringa oleifera* is highly palatable and nutritious fodder and therefore partial or complete replacement of berseem with Moringa is highly recommended in the practices feeding of sheep. *Moringa oleifera* stems are suitable for feeding sheep and can be used to replace a part of clover hay or CFM without any adverse effect on the performance of Rahmani lambs (Mahmoud, 2013).

Many researchers are attention of using *Moringa oleifera* leaves as animal feed, but it's still highly expensive in our country and we can use plant stems in ruminants diets and study the potentiality of its vital components as animal feed. So, the objective of this study was to evaluate the effect of feeding of *Moringa oleifera* stems to lactating Friesian cows on intake, digestibility, rumen and blood parameters, milk yield and composition, feed conversion and economic efficiency.

MATERIALS AND METHODS

The present work was carried out at Sakha Animal Production Research Station, belonging to Animal Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture in Co-operation with Department of Animal Production, Faculty of Agriculture, Kafr El-Sheikh University.

Experimental animals and rations:

Fifteen of lactating Friesian cows with average live body weight of 500 kg (2-4 seasons of lactation) were chosen after the peak of milk yield, divided into three groups (5 each) and assigned randomly into three experimental rations by random complete design for 90 days. Control ration (R1) consisted of 40% concentrate feed mixture (CFM) + 20% corn silage (CS) + 20% rice straw (RS) + 20% barseem hay (BH) based on dry matter, While the tested rations contained 10 and 20% *Moringa oliefera* stems (MS) instead of 50 and 100% of BH in R2 and R3, respectively.

Management procedure:

Animals were fed covering their requirements recommended according to NRC (2001) feeding allowances for dairy cows and adjusted every week based on their body weight and milk production. The amount of CFM was offered twice daily at 8 a.m. and 4 p.m. while, CS, BH and MS were offered daily at 9 a.m., while RS was offered at 11 a.m. Fresh water was available continuously.

Digestibility trials:

Digestibility trails were conducted simultaneously on the animals of feeding trial using 3 cows from each group to determine the digestibility and feeding values of the experimental rations. Each digestibility trial consisted of 15 days as preliminary period followed by 7 days as collection period. Acid insoluble ash was used as a natural marker (Van keulen and Young, 1997). Feces samples were taken from the rectum of each cow twice daily with 12 hrs interval during the collection period. Samples of feedstuffs were taken at the beginning, middle and end of the period. Chemical analysis of samples of CFM, CS, BH, RS and MS as well as feces samples were carried out according to the method of AOAC (1990). Nutrient digestibility was calculated from the equation stated by Schneider and Flat (1975) as follows:

DM digestibility % =100 - $\left(\frac{\text{AIA \% in feed}}{\text{AIA \% in feces}} \times 100\right)$

Nutrient digestibility % = 100 - (100 $\times \left(\frac{\text{AIA \% in feed}}{\text{AIA \% in feces}} \times \frac{\text{Nutrient \% in feces}}{\text{Nutrient \% in feed}}\right)$

Where, AIA is acid insoluble ash.

Milk yield and composition: Cows were mechanically milked and daily milk yield was recorded individually and 4% fat corrected milk (FCM) was calculated using the formula of Gains (1928) as follows: 4% FCM =0.4*milk yield (kg) +15* fat yield (kg)

Milk samples from consecutive evening and morning milking were taken every week during the experimental period and mixed in proportion to milk yield. Composite milk samples were analyzed for fat, protein, lactose, solids not fat (SNF) and total solids (TS) using milkoscan, model 133 B. Ash was determined by the difference.

Rumen liquor samples:

Rumen liquor samples were taken from cows at 3 hr. after the morning feeding using stomach tube with draw pulse power of the automatic milking machine. Every sample was strained through four layers of cheese cloth and rumen pH was determined immediately after straining the samples using Orian 680 digital pH meter. Ammonia nitrogen (NH_3-N) was determined using saturated solution of magnesium oxide distillation according to the method of AOAC (1990). Total volatile fatty acids (TVFA's) were determined by the steam distillation method described by Warner (1964).

Blood samples:

Blood samples were taken from the jugular vein of cows at 3 hrs after the morning feeding in centrifuge tubes containing anticoagulant (EDTA). Then centrifuged for 15 minutes at 4000 rotations per minute to obtain plasma and kept in deep freezer until analysis. Blood plasma protein, albumin, globulin (by difference), urea nitrogen, AST and ALT were determined calorimetrically using commercial diagnostic kits (test-combination, Pasteur lap).

Feed conversion:

The feed conversion was expressed as the amounts of DM, TDN and DCP required for producing 1kg 4%FCM.

Economic efficiency:

Economic parameters expressed as a daily feed cost, feed cost per one kg 4% FCM and price of 4% FCM yield were calculated. Also, economic efficiency as the ratio between the price of 4% FCM yield and daily feed cost was calculated.

Statistical analysis:

The data were statistically analyzed using general linear model procedure adopted by IBM SPSS Statistics 22 (SPSS, 2014) for user's guide with one-way ANOVA. Also, Duncan test within program of SPSS was done to determine the degree of significance among the means.

RESULTS AND DISCUSSION

Chemical composition:

The proximate composition of feedstuffs and experimental rations are presented in Table (1). The obtained results indicated that the contents of CP, CF and ash were higher, while the contents of OM, EE and NFE were lower in *Moringa oliefera* stems compared with berseem hay. So, the contents of CP, CF and ash tended to increase, but the contents of OM, EE and NFE tended to decrease with increasing the level of *Moringa oliefera* stems and decreasing the level of berseem hay in the rations. Such values of chemical composition and the proportion of the experimental feedstuffs (ingredients) which formulated the experimental rations mainly reflected on its chemical composition as shown in Table 1. Similar results obtained by Mahmoud (2013) who found that *Moringa oleifera* stems (MS) contained high protein, ash, CF and low OM, EE and NFE contents compared to clover hay (CH).

Nutrients digestibility and feeding values:

Nutrients digestion coefficients and feeding values for experimental rations are shown in Table (2). Ration contained 10% *Moringa oliefera* stems (R2) recorded significant ($P<0.05$) higher digestion coefficients of DM, OM and CP than those of control one, being the differences did not significant with other tested ration (R3). While, the digestion coefficients of CF and NFE as well as TDN value were insignificantly affected by the dietary treatments. The DCP value of R2 and R3 increased significantly by

Table (1): Chemical composition of feedstuffs and the experimental rations.

Item	DM %	Composition of DM %					
		OM	CP	CF	EE	NFE	Ash
Feedstuffs:							
Concentrate feed mixture	89.88	92.51	16.71	11.32	2.37	62.11	7.49
Berseem hay	91.21	90.10	12.39	28.49	3.10	46.12	9.90
Corn silage	30.12	94.95	9.85	19.91	2.47	62.72	5.05
Rice straw	89.79	83.51	3.62	33.47	1.92	44.50	16.49
Moringa oliefera stems	90.22	88.52	14.50	33.63	2.48	37.91	11.48
Experimental ration:							
R1 (Control)	64.45	90.72	11.86	20.90	2.45	55.51	9.28
R2 (10% MS)	64.40	90.56	12.07	21.42	2.38	54.69	9.44
R3 (20% MS)	64.38	90.40	12.28	21.93	2.32	53.87	9.60

7.21 and 7.65% compared with R1, respectively. The better digestibility in cows with *Moringa* stems additive may be a subsequence of antimicrobial and antioxidant effects of *Moringa oleifera*, which considerably discussed by some researchers. In general, the higher digestibility values of most nutrients obtained on tested rations may be attributed to the effect of feeding such high quality roughages (CS, BH and MS) which provided stimulatory factors to rumen cellulolytic and other bacteria. These factors resulted in some changes in digestive function which led to increasing the availability and utilization of nutrients in the rumen and could have a significant impact on digestion and feeding values of experimental rations. Jabeen *et al*. (2008) mentioned that the antimicrobial properties of the *Moringa oleifera* seed extracts may be due to lipophilic compounds. These compounds may attach to the cytoplasmic membrane. Also, Talha (2013) also suggested that extracts of *Moringa oleifera* seeds may contain antibiotic compounds, such as carboxylic acid, 2,4-diacetyl phloroglucinol, and cell wall-degrading enzymes and chitinases. The antioxidant effect of *Moringa oleifera* leaf extract and fruit was explained by Luqman *et al.* (2012), who noticed that it was due to the presence of polyphenols, tannins, anthocyanin, glycosides, and thiocarbamates, which remove free radicals, activate antioxidant enzymes, and inhibit oxidases.

Table (2): Nutrients digestion coefficients and feeding values for different rations.

Item	Experimental rations			SEM
	R1	R2	R3	
		Digestibility %		
DM	66.65[b]	70.13[a]	69.73[a]	0.61
OM	68.9[b]	72.46[a]	72.03[ab]	0.71
CP	77.16[b]	81.24[a]	80.18[ab]	0.71
EE	67.48[ab]	66.00[b]	68.42[a]	0.54
CF	67.47	66.76	67.22	1.33
NFE	67.34	69.02	67.99	0.79
		Feeding values %		
TDN	64.35	65.38	64.79	0.79
DCP	9.15[b]	9.81[a]	9.85[a]	0.15

a, b: Values in the same row with different superscripts differ significantly (P<0.05).

Control ration (R1) consisted of 40% concentrate feed mixture (CFM) + 20% corn silage (CS) + 20% rice straw (RS) + 20% barseem hay (BH) based on dry matter, While the tested rations contained 10 and 20% Moringa oliefera stems (MS) instead of 50 and 100% of BH in R2 and R3, respectively.

Feed intake:

Average daily feed intake for the different groups is presented in Table (3). There were no significant differences (P>0.05) in average daily feed intake among the dietary treatments. Total DM intake tended to increase with R2, while TDN, CP and DCP intake tended to increase with R2 and R3. The so far equality in feed intake (DM & TDN) between the control ration that contained 20% BH and the tested ration that contained 20% MS is meaning that MS have the same nutritive value of BH that well known consider as one of the most high quality roughage sources for feeding ruminants. These results agreed with those obtained by Mahmoud (2013) who indicated that feed intake by lambs was nearly similar with the same ratio of roughage concentrate as well as with the same ratio of clover hay and *Moringa* stems.

Table (3): Daily feed intake (kg/head/day) for the experimental cows.

Item	Experimental rations			SEM
	R1	R2	R3	
Concentrate feed mixture*	7.08	7.17	7.07	
Berseem hay	3.49	1.77	-	
Corn silage*	10.56	10.69	10.55	
Rice straw*	3.54	3.59	3.54	
Moringa oliefera stems*	-	1.78	3.52	
Total DM	15.90	16.10	15.89	0.27
TDN	10.23	10.53	10.30	0.15
CP	1.89	1.94	1.95	0.07
DCP	1.45	1.58	1.57	0.04

** as fed.*

Control ration (R1) consisted of 40% concentrate feed mixture (CFM) + 20% corn silage (CS) + 20% rice straw (RS) + 20% barseem hay (BH) based on dry matter, While the tested rations contained 10 and 20% Moringa oliefera stems (MS) instead of 50 and 100% of BH in R2 and R3, respectively.

Rumen fermentation activities:

Results of rumen fermentation activities are shown in Table (4). Rumen liquor parameters did not significantly (P>0.05) alter with replacing berseem hay by *Moringa* stems. Ruminal pH value and the concentrations of TVFA's and NH_3-N were nearly similar for the different groups being 6.36, 6.24 and 6.26; 6.33, 6.38 and 6.82 meq/100 ml and 24.86, 25.01 and 24.25 mg/100 ml, respectively. The means of pH values of cows fed the experimental rations are within the normal range as mentioned by Hungate (1996) being 5.5 to 6.85. Mahmoud (2013) indicated that inclusion of MS in tested rations had created similar rumen environment in relation to TVFA's production that showed closer values for all dietary rations either before or after feeding. Ammonia-N concentration was within the normal range described by Church (1976), being 10 to 45 mg/100 ml depending on composition of the ration, time of sampling and method of analysis used. The closely comparable values of NH_3-N among the dietary treatments could be explained as that either content or biological value index of protein in both and MS are greatly similar between them and consequently they having similar effects on the metabolic processes in the tissues and different organs of animals. The present results are in agreement with findings obtained by Mahmoud (2013) who found no significant differences in respect of rumen fermentative parameters (pH, NH_3-N and TVFA's) when compared between rations contained either 25% clover hay or 25% Moringa stems with growing lambs. On the other hand, Khayyal *et al*. (2015) with the whole Moringa forage found that rumen liquor pH values and NH_3-N concentration were unaffected significantly when substituted 25% fresh berseem by the same percent of Moringa forage, but at the high substitution rates 50, 75 and 100% of berseem by Moringa, the values of pH and NH_3-N tended to be lower significantly in Moringa-rations than those of berseem ones. The TVFA's concentration followed inverse trend among the experimental rations.

Table (4): Rumen fermentation activity for the experimental cows.

Item	Experimental ration			SEM
	R1	R2	R3	
pH value	6.36	6.24	6.26	0.17
TVFA's (meq/100 ml)	6.33	6.38	6.82	0.28
NH_3-N (mg/100 ml)	24.86	25.01	24.25	1.45

Control ration (R1) consisted of 40% concentrate feed mixture (CFM) + 20% corn silage (CS) + 20% rice straw (RS) + 20% barseem hay (BH) based on dry matter, While the tested rations contained 10 and 20% Moringa oliefera stems (MS) instead of 50 and 100% of BH in R2 and R3, respectively.

Blood biochemical:

Results of some blood parameters are shown in Table (5). Total protein, albumin and globulin concentrations in blood plasma were insignificant higher with low level MS-ration (R2) and significant higher with high level MS-ration (R3) compared with the control one (R1). While, the concentrations of urea-N and creatinine were behaved the inverse trend among dietary treatments. Otherwise, the activities of liver AST and ALT enzyme were nearly similar for the different groups. Plasma total protein was within the normal range being 6-8 g/dl (Kancko, 1989). Blood plasma transaminase enzymes activities (ALT and AST) are the most important indicators of liver cells activities where increasing the concentration of these enzymes indicate that tissue activity are destroyed (Molander *et al.*, 1957). According to Maxwell *et al.* (1990), blood parameters are important in assessing the quality and suitability of feed ingredients in farm animals. Animashahun *et al*. (2006) affirmed that the comparison of blood chemistry profile with nutrient intake might indicate the need for adjustment of certain nutrients upward or downward for different groups. The results obtained by Mahmoud (2013) revealed that the concentrations of blood total protein, albumin and globulin did not significant changed by substituted 25% of clover hay by Moringa stems in the rations of growing lambs. The same author observed the same effects on the concentrations of urea, creatinine and liver enzymes. On the other hand, mostly the findings obtained by Khayyal *et al*. (2015) in respect of most blood metabolites they were not affected significantly by the low levels of replacing (25 or 50%) fresh berseem by fresh of whole Moringa forage. While with the high rates of replacement (75 or 100%), the Moringa rations have a positive effect on blood metabolites of growing lambs.

Table (5): Blood plasma metabolites for the experimental cows.

Item	Experimental rations			SEM
	R1	R2	R3	
Total protein (g/dl)	7.10^{b}	7.62^{ab}	7.96^{a}	0.28
Albumin (g/dl)	3.68^{b}	4.06^{ab}	4.32^{a}	0.17
Globulin (g/dl)	3.42^{b}	3.56^{ab}	3.64^{a}	0.24
Urea-N (g/d)	28.44^{a}	25.3^{ab}	22.92^{b}	0.83
Creatinine (g/d)	1.36^{a}	1.10^{ab}	1.01^{b}	0.066
AST (U/L)	44.42	43.38	42.24	0.53
ALT (U/L)	14.58	13.54	13.08	0.31

a, b: Values in the same row with different superscripts differ significantly (P<0.05).
Control ration (R1) consisted of 40% concentrate feed mixture (CFM) + 20% corn silage (CS) + 20% rice straw (RS) + 20% barseem hay (BH) based on dry matter, While the tested rations contained 10 and 20% Moringa oliefera stems (MS) instead of 50 and 100% of BH in R2 and R3, respectively.

Milk yield:

Results of milk yield are shown in Table (6). Average daily yield of actual milk and 4% FCM increased insignificantly (P>0.05) with low level MS (R2) and increased significantly with the high level MS ration (R3) compared with the control ration (R1). Actual milk yield of R2 and R3 increased by 8.88 and 11.34% compared with R1, respectively. The corresponding values for 4% FCM were 10.72 and 16.49%, respectively. These results seemed that *Moringa oleifera* has a positive effect on the rumen environment, leading to increased rumen microbial output or to the fact that the protein in *Moringa oleifera* has good rumen bypass characteristics. These results agreed with those obtained by Reyes–Sanchez *et al*. (2006) who reported an increase (P<.0.05) in milk production from 3.1 to 4.9 and 5.1 kg/day when *Moringa oleifera* foliage was supplemented by 2 or 3 kg DM in the diet of cows, respectively. Likewise, Sarwatt *et al*. (2002) reported that milk yield with goats was increased ($P<0.05$) due to feeding *Moringa oleifera* leaves in replacing sunflower seed cake. Reyes–Sanchez *et al*. (2006) pointed out that increase in milk yield might be due to increase CP intake. Cows supplemented with *Moringa oleifera* had 13% and 30% higher milk production than cows fed a basal diet of Hyparreniaruffa grass or Sorghum vulgar straw, respectively (Rocha and Mendieta, 1998 and Foidl *et al*., 2001). Khalel *et al.* (2014) found that actual milk and 4% FCM yields were increased ($P<0.05$) with rations contained either 20 and 40% *Moringa* forage by 16.00 and 25.40% than those fed 40% berseem ration. Generally, Mahmoud (2013) found that no significant differences in respect of growth performance (meat production) of growing lambs when replacing 25% of either CFM or clover hay by *Moringa oleifera* stems in their rations. It fully emphasized that the outcome of each digestible energy or metabolizable energy or net energy that released from clover hay ration is equal to that released from Moringa stems ration and naturally in consequent both forage types have the same effect on productive performance.

Milk composition:

Data of milk composition for the experimental dietary treatments are presented in Table (6). Results showed that milk contents of fat, protein, TS and SNF were insignificant higher with the low level of MS in ration (R2), but significant higher with the high level one (R3), than those of control ration (R1). Otherwise, each of lactose and ash contents did not affected by the dietary treatments. The present results regarding milk composition are in harmony with those reported by Khalel *et al*. (2014) who revealed that all milk constituents (%), except lactose content were significant higher with replacing either 50 or 100% of berseem by *Moringa oleifera* fodder in the ration of lactating cows. The current results are in agreement with those reported by Reyes–Sanchez *et al.* (2006) who described the similar findings that cows supplemented with *Moringa oleifera* had more milk fat and CP than cows fed brachiariabrizantha hay alone or with sorghum silage as a basal diet. In perspective, the optimization of the amount and balance of nutrients absorbed from the gut was one of the two areas considered earlier by Clark and Davis (1983) to have the greatest potential for nutritional improvement for milk production. The other area identified by the same authors as having major potential was the partitioning of absorbed and stored nutrients to support lactation.

Table (6): Average milk yield and composition for experimental animals during lactation period.

Item	Experimental rations			SEM
	R1	R2	R3	
		Average milk yield, kg/day		
Milk	14.64^{b}	15.94^{ab}	16.30^{a}	0.34
Increase%	0.00^{c}	8.88^{b}	11.34^{a}	1.72
4% F C M	13.34^{b}	14.77^{ab}	15.54^{a}	0.38
Increase %	00.00^{c}	10.72^{b}	16.49^{a}	2.42
		Milk composition, %		
Fat	3.41^{b}	3.51^{ab}	3.69^{a}	0.07
Protein	2.70^{b}	2.82^{ab}	2.88^{a}	0.05
Lactose	4.65	4.70	4.81	0.07
TS	11.45^{b}	11.73^{ab}	12.09^{a}	0.19
SNF	8.04^{b}	8.22^{ab}	8.40^{a}	0.13
Ash	0.69	0.70	0.71	0.01

a, b, c: Values in the same row with different superscripts differ significantly ($P<0.05$).
Control ration (R1) consisted of 40% concentrate feed mixture (CFM) + 20% corn silage (CS) + 20% rice straw (RS) + 20% barseem hay (BH) based on dry matter, While the tested rations contained 10 and 20% Moringa oliefera stems (MS) instead of 50 and 100% of BH in R2 and R3, respectively.

Feed conversion ratio:

Feed conversion ratio expressed as the amounts of DM, TDN and DCP per 1 kg 4% FCM are shown in Table (7). Results indicated that feed conversion (as kg DM/TDN per kg 4% FCM) was insignificant improved with low level of MS ration (R2) and significant improved with the high level MS ration (R3) compared with those of control one (R1). While, the feed conversion (as kg CP/CP per kg 4% FCM) did not significant affected by dietary treatments. The improvements of feed conversion with Moringa stems may be attributed to the improvements in nutrients digestibility (Table 2), feed intake (Table 3), rumen fermentation activity (Table 4) and milk yield (Table 6). These results are in accordance with those obtained by Mahmoud (2013) who reported that feed efficiency was better for lambs fed ration containing 25% *Moringa oleifera* stems in replace to clover hay or concentrate feed mixture compared to the control ration. Such improvements might be due to the beneficial effects of *Moringa* that providing stimulator factors and essential nutrients especially protein, energy, minerals and vitamins that better utilized by sheep. Obtained results in the present study are in match with those obtained by Khalel *et al*. (2014) who found that cows fed rations formulated with 50 or 100% Moringa fodder in replacing with fresh berseem gave significant better feed conversion in comparison with the berseem ration. Definitely, due to the enrichment of Moringa fodder by the vital macro/micro nutrients like essential amino acids, vitamins, trace elements and others, and therefore it has a potential positive associative effect with the other ingredients of ruminant rations which in consequent beneficially reflection on the feed conversion and feed efficiency (Huhtanen, 1991).

Table (7): Feed conversion and economic efficiency for the experimental rations.

Item	Experimental rations			SEM
	R1	R2	R3	
Feed conversion:				
DM, kg/kg FCM	1.19^{a}	1.09^{ab}	1.02^{b}	0.04
TDN, kg/kg FCM	0.77^{a}	0.71^{ab}	0.66^{b}	0.02
CP, kg/kg FCM	0.14	0.13	0.13	0.008
DCP, kg/kg FCM	0.11	0.11	0.10	0.006
Economic efficiency:				
Feed cost, LE/day	47.55^{a}	46.58^{ab}	44.39^{b}	1.43
Feed cost (LE)/ kg 4% FCM	3.56^{a}	3.15^{ab}	2.86^{b}	0.16
Price of 4% FCM yield, LE/day	60.48^{b}	66.47^{a}	69.93^{a}	1.75
Economic efficiency	1.27^{b}	1.43^{ab}	1.58^{a}	0.12

Control ration (R1) consisted of 40% concentrate feed mixture (CFM) + 20% corn silage (CS) + 20% rice straw (RS) + 20% barseem hay (BH) based on dry matter, While the tested rations contained 10 and 20% Moringa oliefera stems (MS) instead of 50 and 100% of BH in R2 and R3, respectively.
a, b: Values in the same row with different superscripts differ significantly (P<0.05).
Prices of one kg were 4.70 LE for CFM, 2.10 LE for BH, 0.50 LE for CS, 0.32 LE for RS, 1.20 LE for MS and 4.50 LE for 4% FCM according to prices 2017.

Economic efficiency:

Data of economic efficiency presented in Table (7) showed that the high level of MS ration (R3) resulted insignificant (P>0.05) improvement in economic efficiency compared with that of control one, being the difference did not significant between the low level of MS ration (R2) and control one. Average daily feed cost and feed cost per kg 4% FCM were insignificant lower with low level of MS ration (R2) and significant lower with high level of MS ration (R3) compared with control one (R1). While, the price of 4% FCM yield was significantly higher (P<0.05) with 10 and 20% MS rations compared to R1. Moreover, economic efficiency was significant higher in R3 (20% MS) and insignificant higher in R2 (10% MS) compared with control one (R1). Results here are in agreement with those obtained by Khalel *et al*. (2014) who worked with cows and Khayyal *et al*. (2015) who worked with growing lambs and they were reported that the economical efficiency significant better with the different levels of Moringa fodder included in the rations versus those having fresh berseem in the corresponding ones.

CONCLUSION

It could be concluded that introducing *Moringa oleifera* stems at the level of 20% in replacing all berseem hay in the ration of lactating cows recorded the best results concerning digestibility, some blood plasma parameters, milk yield and composition, feed conversion and economic efficiency.

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تأثير التغذية على سيقان المورينجا على الاداء الإنتاجي للأبقار الفريزيان الحلابة

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هذه الدراسة كانت على تأثير استبدال دريس البرسيم بسيقان المورينجا. تم استخدام 15 بقرة حلابة بمتوسط وزن 500 كجم وتم تغذيتها طبقا" لمقررات NRC (2001) . وقسمت الى ثلاث مجاميع وتم تغذية المجموعة الاولى على عليقة تتكون من 40%علف مركز، 60% علف مالئ (20% دريس برسيم+ 20% قش ارز+ 20% سيلاج ذرة) أما علائق المجموعتين الثانية والثالثة تم ادخال سيقان المورينجا بمعدل 10، 20% لتحل محل 50، 100% من دريس البرسيم على التوالى.

أظهرت النتائج أن محتوى كل من البروتين الخام، الألياف الخام والرماد تميل الى الزيادة، بينما محتوى كل من المادة العضوية، المستخلص الاثيرى والمستخلص الخالى من الأزوت تميل الى النقص مع زيادة مستوى سيقان المورينجا فى العلائق. ارتفاع هضم المادة الجافة، المادة العضوية والبروتين الخام معنويا في العليقة الثانية المحتوية على 10% سيقان مورينجا وغير معنوى في العليقة الثالثة المحتوية على 20% سيقان مورينجا عنه في العليقة الأولى (المقارنة). فضلا عن ذلك لم يتأثر هضم الألياف والمستخلص الخالى من الأزوت ومحتوى المركبات الكلية المهضومة معنويا بالمعاملات. ارتفع محتوى البروتين الخام المهضوم معنويا في كل من العليقتين التجريبيتين عنه في المقارنة. وبصفة عامة كان أعلى هضم لمعظم العناصر الغذائية والقيم الغذائية في العليقة الثانية وأقلها مع المقارنة. لا توجد اختلافات معنوية فى كمية الغذاء المأكول ونشاط تخمرات الكرش بين المجموعات المختلفة. زيادة تركيز البروتينات الكلية، الألبيومين، الجلوبيولين معنويا فى بلازما الدم، بينما انخفض تركيز اليوريا والكرياتينين معنويا مع زيادة مستوى سيقان المورينجا فى العلائق. زيادة انتاج اللبن الفعلى والمعدل 4% دهن وكذلك النسبة المئوية لكل من الدهن والبروتين والجوامد الصلبة الكلية والجوامد الصلبة اللادهنية فى اللبن غير معنوى مع العليقة الثانية المحتوية على 10% سيقان مورينجا ومعنويا مع العليقة الثالثة المحتوية على 20% سيقان مورينجا بالمقارنة بعليقة المقارنة. ووجد تحسن فى التحويل الغذائي غير معنوى في العليقة الثانية المحتوية على المستوى المنخفض من سيقان المورينجا، بينما كان التحسن معنويا في العليقة الثالثة المحتوية على المستوى المرتفع من سيقان المورينجا عنه في العليقة الأولى (عليقة المقارنة). أيضا أدى استخدام سيقان المورينجا فى التغذية الى خفض تكلفة التغذية اليومية وتكلفة التغذية لكل 1 كجم 4% دهن وزيادة العائد من اللبن 4% دهن وبالتالي الكفاءة الاقتصادية.

نستخلص من هذه الدراسة أن ادخال سيقان المورينجا بمستوى 20% لاستبدال كل دريس البرسيم في علائق الأبقار الحلابة سجل أفضل النتائج بخصوص الهضم، بعض قياسات بلازما الدم، انتاج اللبن وتركيبه، التحويل الغذائي والكفاءة الاقتصادية.